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(54) **CASCADE CONNECTION OF COMMUNICATING DEVICES**

KASKADIERTER ANSCHLUSS VON KOMMUNIZIERENDEN GERÄTE

CONNEXION EN CASCADE DE DISPOSITIFS DE COMMUNICATION

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Description

[0001] The present invention relates to the cascade connection of a plurality of devices so as to enable them to communicate and function together.

[0002] In, for example, computer networks comprising a number of users there are provided communication hubs which enable the users to communicate with each other. The communication hub would typically comprise a plurality of ports to which the users would be connected, and would also comprise means to enable the ports to communicate with each other, thereby allowing the different users to communicate. As is well known, the connections between the ports may be arranged in various ways, for instance the device may be what is known as a repeater, in which communications received on one port are simply output on all of the other ports, or the device may be what is known as a bridge, in which data received on any port is only output to that port for which it is destined, or it may be any other form of communications device. In such an arrangement, the capacity of the network, in terms of the number of users which may be connected, is limited by the number of ports provided on the communications device. If it is desired to increase the capacity of the network it would of course be possible to replace the communications device with another device having an increased number of ports. However, this is generally considered not to be a good solution both in terms of wastage (the original device becomes redundant) and also in terms of product supply (a manufacturer must have in its product range a potentially large number of differently sized products).

[0003] A better approach to the problem is to provide communications devices which may themselves be connected together in what may be considered to be a "stack" such that when the capacity of existing equipment is exhausted further capacity may be added by simply adding an additional device to the stack. In such a stack it is necessary to provide interconnection between the stacked devices via what is known as a cascade connection, in order to allow users connected to one device to communicate with users connected to other devices.

[0004] WO 94 08305A and EP 0 266 016 A disclose general aspects of sensing whether a device is at the end of a series of cascade connected devices.

[0005] The present invention provides a network communication device comprising a plurality of ports whereby connections can be made to network equipment and connection means arranged to enable connection to two other similar devices whereby a plurality of said devices may be cascade connected, the device comprising means for determining an identification of its position in a series of cascade connected devices, said means comprising:

an input;

an output arranged to be connected to the input of another device when devices are cascade connected;

means arranged to generate pulses of a predetermined duration and to output said pulses via said output when no signal is received via said input;

means arranged to receive pulses via said input, to extend the duration of said pulses by said predetermined period and to output the extended pulses via said output; and

means arranged to determine the identification of the device according to the duration of the pulses received at said input.

[0006] The present invention additionally provides a device as just defined, further comprising sensing means arranged to sense whether the device is at the end of a series of cascade connected devices, said sensing means comprising:

[0007] first and second complementary circuitry providing first and second outputs respectively and having first and second interconnections respectively, the first and second circuitry being arranged whereby said first output has a first value in the event that said first interconnection is connected to a second interconnection in another device and a second value if it is not so connected, and whereby said second output has a first value in the event that said second interconnection is connected to a first interconnection in another device and a second value if it not so connected; and

means arranged to indicate that said device is at the end of a series of cascade connected devices when one of said first and second outputs takes it second value.

[0008] The present invention facilitates the stacking of devices by a user and reduces the amount of manual setting up of the stack of devices which is required to be undertaken by a user.

[0009] This automatic detection provided by the present invention enables each of the devices in the stack automatically to be individually identifiable by an external management means, without the need for setting physical switches on the devices by a user, which is open to error. The automatic generation of the position identification for each device means that the stack can be re-configured by addition or removal of devices and these alterations will automatically be taken into account by the stack as a whole.

[0010] In the preferred implementation of the invention it is only necessary to provide two additional connections in the cascade connection between the network communication devices to provide the function of detecting the end of the stack.

[0011] Also in the preferred implementation the automatic ID generation requires only one additional connection in the cascade.

[0012] In a preferred development of the invention the devices are also provided with suitable circuitry for terminating the communication bus which is effectively

provided by the cascade connection of the devices, and this termination circuitry is switched on to the cascade connection if the device is at the end of the stack.

[0013] In one implementation of the invention the devices are connected in cascade by the provision of two connectors on each device and the devices are serially connected together by way of a plurality of cables between the first connector on one box and the second connector on the next box.

[0014] In such an arrangement, the removal of a device in the middle of the stack causes the stack to be divided in two. In order to avoid the possible disadvantages of this, in a preferred embodiment, a further device is provided which is connected between the cables and each device which enables the removal of a communications device without breaking the cascade connection of the remaining devices.

[0015] As mentioned above this invention is particularly applicable to data communication devices in computer networks and in a particular embodiment of this invention, due to the low number of extra connections which are required to perform the above-mentioned automatic functions of the cascade, it is possible to provide five independent communication links in the stack using only 25- way connectors for the cascade.

[0016] This invention will be better understood from the following description of a preferred embodiment given by way of example and in conjunction with the accompanying drawings in which:-

Figure 1 illustrates the cascade connection of four devices ;

Figure 2 illustrates in more detail the arrangement of Figure 1 according to the preferred embodiment;

Figure 3 illustrates the allocation of identification within a stack;

Figure 4 illustrates the end-of-stack sensing devices; and

Figure 5 illustrates the operation of a connecting device according to a particularly preferred embodiment.

[0017] Figure 1 illustrates in schematic and illustrative form a plurality of four devices 100 connected in a cascade. Each device comprises a "upstream" connection 101 and a "downstream" connection 102. The devices in the stack are connected by way of cables 50 which connected the downstream connection of one box with the upstream connection of the next box. (It is to be understood that the terms "upstream" and "downstream" are used simply to indicate the two directions in the stack. Communication between the devices within the stack takes place in both directions.)

[0018] Each cable 50 comprises a plurality of wires which connect to a plurality of pins within the connectors on each device in the stack.

[0019] Figure 2 is a schematic diagram illustrating in more detail the connections formed within the devices within the stack and formed by the connecting cables 50. As is illustrated, a subset 52 of the plurality of signals carried by cables 50 is provided to enable to devices in the stack to communicate with each other as desired to provide their normal functions. As shown, these signals 52 are simply transferred in parallel from the upstream connector of one device to the downstream connector of the subsequent device and are also connected in parallel between the upstream and downstream connectors within each device. This effectively provides a communication bus running up the stack and for the purposes of illustration core devices 110 are illustrated within each device 100 which communicate with each other via the communication bus. This communication may be by any method and is not fundamental to the basics of this invention, although a specific scheme will be discussed later.

[0020] There are additionally provided three pins on each connector on each box which are connected as shown via two wires 54 in cable 50. These connections enable the automatic determination of the positions within the stack by the different devices. Within each device there is provided means 120 for determining the current identification of each device in the stack and also devices 130 which are arranged to sense if the device is at the top or bottom of the stack.

[0021] As shown the signal output from each device 120 is connected to the input of the subsequent device 120. This enables each device 100 to generate its own identification based on the identification of the adjacent device in the stack which results in each device in the stack assigning to itself a unique identification code.

[0022] One implementation of this is illustrated in Figure 3 which illustrates the connections of the device 120. Each of these devices is configured such that when nothing is connected to its input it provides at its output a pulse train in which the width of each pulse is w1 and time between pulses is T. This is illustrated in Figure 3B. For subsequent devices 120, each device receives the pulse train output by the preceding device and increases the width of the pulses in the pulse train by units of w1, without altering the period T. Each device determines it own identification by measuring the width of the pulses received on the input. Therefore in the configuration illustrated in Figure 3A, the first box 120 takes identification 0, the next takes the identification 1, the next takes the identification 2 and the final box takes identification 3.

[0023] The generation of the pulse trains just mentioned takes place continually and therefore any alterations to the size or configuration of the stack are automatically accounted for. For instance, if a further device is added at the top of the stack this automatically takes the next identification available. If a extra device is added at the bottom of the stack, this automatically takes identification number 0, with the other devices renumbering themselves automatically. This configuration therefore ensures that at any given time. each device in

the stack has a unique identification which is indicative of its relative position within the stack.

[0024] Another connection provided by cable 50 runs between units 130 in the devices in the stack. This is provided to enable the devices to detect if they are at the end of the stack. Within each unit 130 there are provided two complementary devices, each of which is capable of detecting whether it is connected to a complementary device in a succeeding device in the stack. If it is determined that both of the complementary devices are so connected then it is established that the device in question is not at the end of the stack. If only one of the complementary devices is so connected then it is established that the device in question is at the end of a stack. Suitable circuitry for comprising devices 130 is illustrated in Figure 4

[0025] In Figure 4 there are shown in schematic form two units 130, each of which comprises two complementary devices 132, 136. Device 132 has terminal 133 which is connected to a terminal in one of the downstream or upstream connectors of the device 100. Device 136 has terminal 137 which is connected to a terminal in the other of the upstream or downstream connectors. Therefore, by way of one of connections 54, for each connection between devices 100 in a stack there is a connection between a terminal 133 and a terminal 137.

[0026] Considering first device 132, when there is no connection to terminal 133, as illustrated in the left-hand side of Figure 4, no current flows through the resistors of device 132 thereby causing a low signal to be applied to the inverting buffer, which in turn applies a high signal to output terminal 134.

[0027] In device 136, when no connection is made to terminal 137 as illustrated in the right-hand side of Figure 4, the transistor is turned off causing no current to flow through the grounded resistor and setting terminal 138 to have a high value.

[0028] If a device 132 is connected to a device 136 as illustrated in the central portion of Figure 4 the interaction between the two devices 132 and 136 means that the signals at terminals 134 and 138 are now low.

[0029] It will therefore be appreciated that a low signal on a terminal 134 or 138 indicates that a connection to a succeeding device has been made, while a high signal on terminal 134 or 138 indicates that no connection has been made. Devices 130 can therefore perform a simple logical operation on the outputs of terminals 134,138 to determine if termination of the communication bus is desired. In particular if both signals are low then no termination is required, while if one of the signals is high then termination is required.

[0030] The input and output side of devices 130 may use the same number pin in each of the upstream and downstream connectors on each device in the stack. However, as illustrated in Figure 2 it is preferred that the input and output signals use different pins in the upstream and downstream connections and this enables the upstream and downstream connectors to be made physically different, thereby, in conjunction with appropriately manufactured cables 50, ensuring that only correct connections can be made between devices in the stack.

[0031] As mentioned above the determination of whether a device is at the end of the stack can be used to switch appropriate termination circuitry on to the communication bus 52 to prevent reflections at the end of the bus in a known fashion.

[0032] One additional problem which is a stack connected as illustrated in Figures 1 and 2 is that if an intermediate device is removed from the stack simply by unplugging the cables 50 to which it is connected this will result in the remaining devices not being able to communicate with each other, because the stack is divided into two.

[0033] Therefore according to a further preferred feature of this invention there is additionally provided a connector for attachment between the devices in the stack and the cables 50. This is illustrated in Figure 5 and is designated part 60. As illustrated each connecting device 60 comprises connectors 1a and 2a which connect respectively with the upstream and downstream connectors on a device in the stack. The connecting device 60 also comprises connectors 1b and 2b to which cables 50 can be connected. In addition to simply providing a parallel connection for signals 52 between connectors 1a and 1b and between connectors 2a and 2b within connecting device 60, the connecting device also provides a parallel connection for at least signals 52 from connector 1b to connector 2b. The exceptions to this latter feature are the signals 54 which run between devices 120 and 130 as will be discussed in detail below, but it will be appreciated that the parallel connection of signals 52 between connectors 1b and 2b means that even if a device is disconnected from connectors 1a and 2a, the communication between the remaining devices in the stack can continue via connectors 1b and 2b to which the cables 50 are attached.

[0034] The connecting device 60 comprises means for receiving a signal 62 indicating if connectors la and 2a are attached to a device in the stack and, if they are not so connected, the signals running between devices 120 and 130 are simply bussed between connectors 1b and 2b in the same way as the communication signals. Therefore in this event it is as if the connector circuit 60 was not present and the remaining devices in the stack derive their identifications in the normal way as described above.

[0035] If however it is determined that device 60 is connected to a device in the stack by connectors la and 2a the signals 54 running between devices 120 and 130 are not bussed between connectors 1b and 2b by connecting circuit 60 thereby enabling the device to which connector 60 is attached to be accounted for in the identification scheme described above.

[0036] In a particularly preferred embodiment of this

invention the above described cascade arrangement is used for connecting a plurality of repeater devices in a local area network (LAN). Each device may comprise four repeaters connecting a plurality of ports to which users may attach. Each such device has five ports which it is desired to connect to the cascade connection. There are therefore provided five ethernet standard communications busses within the bus provided by cable 50, each one of these being provided by three wires. Each of these three wire links comprises one twisted pair which carries data and one extra wire for collision detection as in a normal ethernet connection. This efficient use of signals in the cascade connection means that the five communications channels plus the device identification signals according to this invention described above can all be accommodated in a single 25-way d-type connector. This is advantageous because such connectors are very standard in this field and are therefore available cheaply enabling the devices according to this embodiment of the invention to be manufactured at relatively low cost.

[0037] In a preferred configuration there are 11 twisted pairs in the cascade connection. As illustrated in Figure 2 there is one no fit pin on the cascade-in connector, and one no fit pin on the cascade-out connector. This leaves only one non-twisted pair connection (i.e. a single wire).

[0038] In such an arrangement one or both of the no fit pins the cascade-out connector and the cascade-in connector may be polarised to provide the unit present signal to the connecting device 60.

Claims

1. A network communication device (100) comprising a plurality of ports whereby connections can be made to network equipment and connection means (101,102) arranged to enable connection to two other similar devices whereby a plurality of said devices may be cascade connected, the device comprising means (120) for determining an identification of its position in a series of cascade connected devices, said means (120) comprising:

   an input;
   an output arranged to be connected to the input of another device when devices are cascade connected;
   means arranged to generate pulses of a predetermined duration and to output said pulses via said output when no signal is received via said input;
   means arranged to receive pulses via said input, to extend the duration of said pulses by said predetermined period and to output the extended pulses via said output; and
   means arranged to determine the identification of the device according to the duration of the pulses received at said input.

2. A network communication device according to claim 1 further comprising sensing means (130) arranged to sense whether the device (100) is at the end of a series of cascade connected devices, said sensing means (130) comprising:

   first and second complementary circuitry (132,136) providing first and second outputs (134,138) respectively and having first and second interconnections (133,137) respectively, the first and second circuitry being arranged whereby said first output (134) has a first value in the event that said first interconnection (133) is connected to a second interconnection (137) in another device and a second value if it is not so connected, and whereby said second output (138) has a first value in the event that said second interconnection (137) is connected to a first interconnection (137) in another device and a second value if it not so connected; and
   means arranged to indicate that said device is at the end of a series of cascade connected devices when one of said first and second outputs takes it second value.

3. A network communication device according to claim 2 in which said first circuitry (132) comprises means arranged to drive said first interconnection (133) to a first logical level and the value of said first output (134) is dependent on whether current is drawn via first interconnection (133), and second circuity (136) comprises means arranged to pull said second interconnection (137) to a second logical level and to sense when said second interconnection is driven to said first logical level.

4. A network communication device according to claim 2 or 3 further comprising a data bus termination device which is activated when it is determined that the device is at the end of a series of cascade connected devices.

5. A communications apparatus comprising a plurality of network communication devices (100) each being a device according to any preceding claim, the devices being interconnected via cable segments (50) attached to said connection means (101,102) whereby to form a data bus.

6. Apparatus according to claim 5 further comprising a cascade connection device (60) connected between said connection means (101,102) of at least one of said network communication devices (100) and the respective cable segments (50) to enable the removal of that communication device (100)

without breaking the cascade connection of the remaining units.

7. Apparatus according to claim 6 in which said cable segments (50) include a conductor to carry said pulses between said outputs and inputs of the network communication devices and the cascade connection device (60) comprises switch means responsive to whether or not the cascade connection device (60) is attached to a network communication device (10) to connect said conductors in the cable segments to the input and output of a said network communication device (10) if present or to connect said conductors in the cable segments together if no said network communication device is present.

Patentansprüche

1. Netzwerkdatenübertragungsvorrichtung (100), die eine Vielzahl von Kanälen umfasst, wodurch Verbindungen zu Netzwerkgeräten und Verbindungsmitteln (101, 102) hergestellt werden können, die angeordnet sind, um eine Verbindung mit zwei anderen ähnlichen Vorrichtungen zu ermöglichen, wodurch eine Vielzahl der Vorrichtungen kaskadiert sein kann, wobei die Vorrichtung eine Einrichtung (120) zum Bestimmen einer Erkennung seiner Position in einer Reihe von kaskadierten Vorrichtungen umfasst, wobei die Einrichtung (120) umfasst:

   einen Eingang;

   einen Ausgang, der angeordnet ist, um mit dem Eingang einer anderen Vorrichtung verbunden zu werden, wenn die Vorrichtungen kaskadiert sind;

   eine Einrichtung, die angeordnet ist, um Impulse von vorbestimmter Dauer zu generieren und um die Impulse über den Ausgang auszugeben, wenn kein Signal über den Eingang empfangen wird;

   eine Einrichtung, die angeordnet ist, um Impulse über den Eingang zu empfangen, um die Dauer der Impulse um die vorbestimmte Zeitdauer zu verlängern und die verlängerten Impulse über den Ausgang auszugeben; und

   eine Einrichtung, die angeordnet ist, um die Erkennung der Vorrichtung gemäß der Dauer der an dem Eingang empfangenen Impulse zu bestimmen.

2. Netzwerkdatenübertragungsvorrichtung nach Anspruch 1, die ferner eine Abtasteinrichtung (130) umfasst, die angeordnet ist, um abzutasten, ob sich die Vorrichtung (100) am Ende einer Reihe von kaskadierten Vorrichtungen befindet, wobei die Abtasteinrichtung (130) umfasst:

   eine erste und zweite komplementäre Schaltung (132, 136), die jeweils einen ersten und zweiten Ausgang (134, 138) bereitstellt und die jeweils eine erste und zweite Verbindung (133, 137) besitzt, wobei die erste und zweite Schaltung angeordnet sind, wodurch der erste Ausgang (134) einen ersten Wert bei dem Ereignis hat, dass die erste Verbindung (133) mit einer zweiten Verbindung (137) in einer anderen Vorrichtung verbunden ist, und einen zweiten Wert, wenn diese nicht derart verbunden ist, und wodurch der zweite Ausgang (138) einen ersten Wert bei dem Ereignis hat, dass die zweite Verbindung (137) mit einer ersten Verbindung (137) in einer anderen Vorrichtung verbunden ist, und einen zweiten Wert, wenn diese nicht derart verbunden ist: und

   eine Einrichtung, die angeordnet ist, um anzuzeigen, dass sich die Vorrichtung an dem Ende einer Reihe von kaskadierten Vorrichtungen befindet, wenn einer der ersten und zweiten Ausgänge einen zweiten Wert annimmt.

3. Netzwerkdatenübertragungsvorrichtung nach Anspruch 2, wobei die erste Schaltung (132) eine Einrichtung umfasst, die angeordnet ist, um die erste Verbindung (133) auf eine erste logische Stufe zu bringen, und der Wert des ersten Ausgangs (134) davon abhängt, ob Strom über die erste Verbindung (133) gezogen wird, und wobei die zweite Schaltung (136) eine Einrichtung umfasst, die angeordnet ist, um die zweite Verbindung (137) auf eine zweite logische Stufe zu setzen, und um abzutasten, wann die zweite Verbindung auf die erste logische Stufe gebracht wird.

4. Netzwerkdatenübertragungsvorrichtung nach Anspruch 2 oder 3, die ferner eine Datenbusabschlussvorrichtung umfasst, die aktiviert wird, wenn bestimmt wird, dass sich die Vorrichtung am Ende einer Reihe kaskadierter Vorrichtungen befindet.

5. Datenübertragungsvorrichtung, die eine Vielzahl von Netzwerkdatenübertragungsvorrichtungen (100) umfasst, wobei jede eine Einrichtung gemäß einem der vorstehenden Ansprüche ist, wobei die Vorrichtungen untereinander über Kabelsegmente (50) verbunden sind, die an den Verbindungsmitteln (101, 102) befestigt sind, um einen Datenbus auszubilden.

6. Vorrichtung nach Anspruch 5, die ferner eine Kaskadierungsvorrichtung (60) umfasst, die zwischen

den Verbindungsmitteln (101, 102) von wenigstens einer der Netzwerkdatenübertragungsvorrichtungen (100) und den entsprechenden Kabelsegmenten (50) verbunden ist, um das Entfernen dieser Datenübertragungsvorrichtung (100) ohne Unterbrechen der Kaskadierung der verbleibenden Einheiten zu ermöglichen.

7. Vorrichtung nach Anspruch 6, wobei die Kabelsegmente (50) einen Leiter einschließen, um die Impulse zwischen den Ausgängen und Eingängen der Netzwerkübertragungsvorrichtungen zu übertragen, und wobei die Kaskadierungsvorrichtung (60) eine Schalteinrichtung umfasst, die darauf reagieren kann, ob die Kaskadierungsvorrichtung (60) an einer Netzwerkübertragungsvorrichtung (10) befestigt ist oder nicht, um die Leiter in den Kabelsegmenten mit dem Eingang und dem Ausgang der Netzwerkübertragungsvorrichtung (10) zu verbinden, wenn diese vorliegt, oder, um die Leiter in den Kabelsegmenten miteinander zu verbinden, wenn keine Netzwerkübertragungsvorrichtung vorliegt.

Revendications

1. Dispositif (100) de communication par réseau comprenant une pluralité d'accès par lesquels on peut faire des connexions à un équipement de réseau et à un moyen (101, 102) agencé pour permettre la connexion à deux autres dispositifs similaires en permettant ainsi de connecter en cascade une pluralité desdits dispositifs, le dispositif comprenant un moyen (120) destiné à déterminer une identification de sa position dans une série de dispositifs connectés en cascade, ledit moyen (120) comprenant :

   une entrée ;
   une sortie agencée pour être connectée à l'entrée d'un autre dispositif lorsque des dispositifs sont connectés en cascade ;
   un moyen agencé pour engendrer des impulsions d'une durée prédéterminée et pour sortir lesdites impulsions, via ladite sortie, lorsqu'aucun signal n'est reçu via ladite entrée ;
   un moyen agencé pour recevoir des impulsions via ladite entrée, pour étendre la durée desdites impulsions de ladite période prédéterminée et pour sortir lesdites impulsions étendues via ladite sortie ; et
   un moyen agencé pour déterminer l'identification du dispositif d'après la durée des impulsions reçues au niveau de ladite entrée.

2. Dispositif de communication par réseau selon la revendication 1, comprenant en outre un moyen (130) de détection agencé pour détecter si le dispositif (100) est à la fin d'une série de dispositifs connectés en cascade, ledit moyen (130) de détection comprenant :

   des premier et second circuits (132, 136) complémentaires fournissant, respectivement, des première et seconde sorties (134, 138) et ayant, respectivement, des première et seconde interconnexions (133, 137), les premier et second circuits étant agencés de façon que ladite première sortie (134) ait une première valeur dans le cas où ladite première interconnexion (133) est connectée à une seconde interconnexion (137) d'un autre dispositif et une seconde valeur si elle n'est pas ainsi connectée, et de façon que ladite seconde sortie (138) ait une première valeur dans le cas où ladite seconde interconnexion (137) est connectée à une première interconnexion (137) d'un autre dispositif et une seconde valeur si elle n'est pas ainsi connectée ; et
   un moyen agencé pour indiquer que ledit dispositif est à la fin d'une série de dispositifs connectés en cascade lorsque l'une desdites première et seconde sorties prend sa seconde valeur.

3. Dispositif de communication par réseau selon la revendication 2, dans lequel ledit premier circuit (132) comprend un moyen agencé pour attaquer ladite première interconnexion (133) à un premier niveau logique et la valeur de ladite première sortie (134) dépend du fait que du courant est tiré via la première interconnexion (133), et dans lequel le second circuit (136) comprend un moyen agencé pour amener ladite seconde interconnexion (137) à un second niveau logique et pour détecter lorsque ladite seconde interconnexion est attaquée audit premier niveau logique.

4. Dispositif de communication par réseau selon la revendication en 2 ans 3, comprenant en outre un dispositif de terminaison de bus de données qui est activé lorsque l'on détermine que le dispositif est à la fin d'une série de dispositifs connectés en cascade.

5. Appareil de télécommunications comprenant une pluralité de dispositifs (100) de communication par réseau, chacun étant un dispositif selon l'une quelconque des revendications précédentes, les dispositifs étant interconnectés via des segments (50) de câble reliés audit moyen (101, 102) de connexion pour former ainsi un bus de données.

6. Appareil selon la revendication 5, comprenant en outre un dispositif (60) de connexion en cascade connecté entre ledit moyen (101, 102) de connexion d'au moins l'un desdits dispositifs (100) de

communication par réseau et les segments (50) de câble respectifs pour permettre d'enlever ce dispositif (100) de communication sans rompre la connexion en cascade des modules restants.

7. Appareil selon la revendication 6, dans lequel lesdits segments (50) de câble comprennent un conducteur pour transporter lesdites impulsions entre lesdites sorties et lesdites entrées des dispositifs de communication par réseau, et dans lequel le dispositif (60) de connexion en cascade comprend un moyen de commutation sensible au fait que le dispositif (60) de connexion en cascade est, ou non, relié à un dispositif (10) de communication par réseau, pour connecter lesdits conducteurs des segments de câble à l'entrée et à la sortie d'un dit dispositif (10) de communication par réseau s'il est présent, ou pour connecter ensemble lesdits conducteurs des segments de câble si aucun dit dispositif de communication par réseau n'est présent.

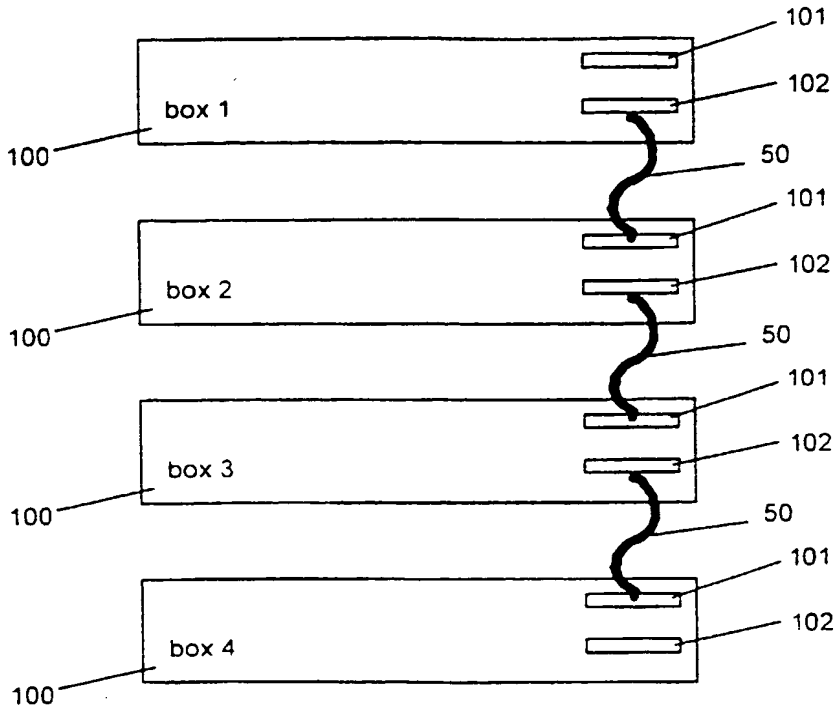

Fig. 1

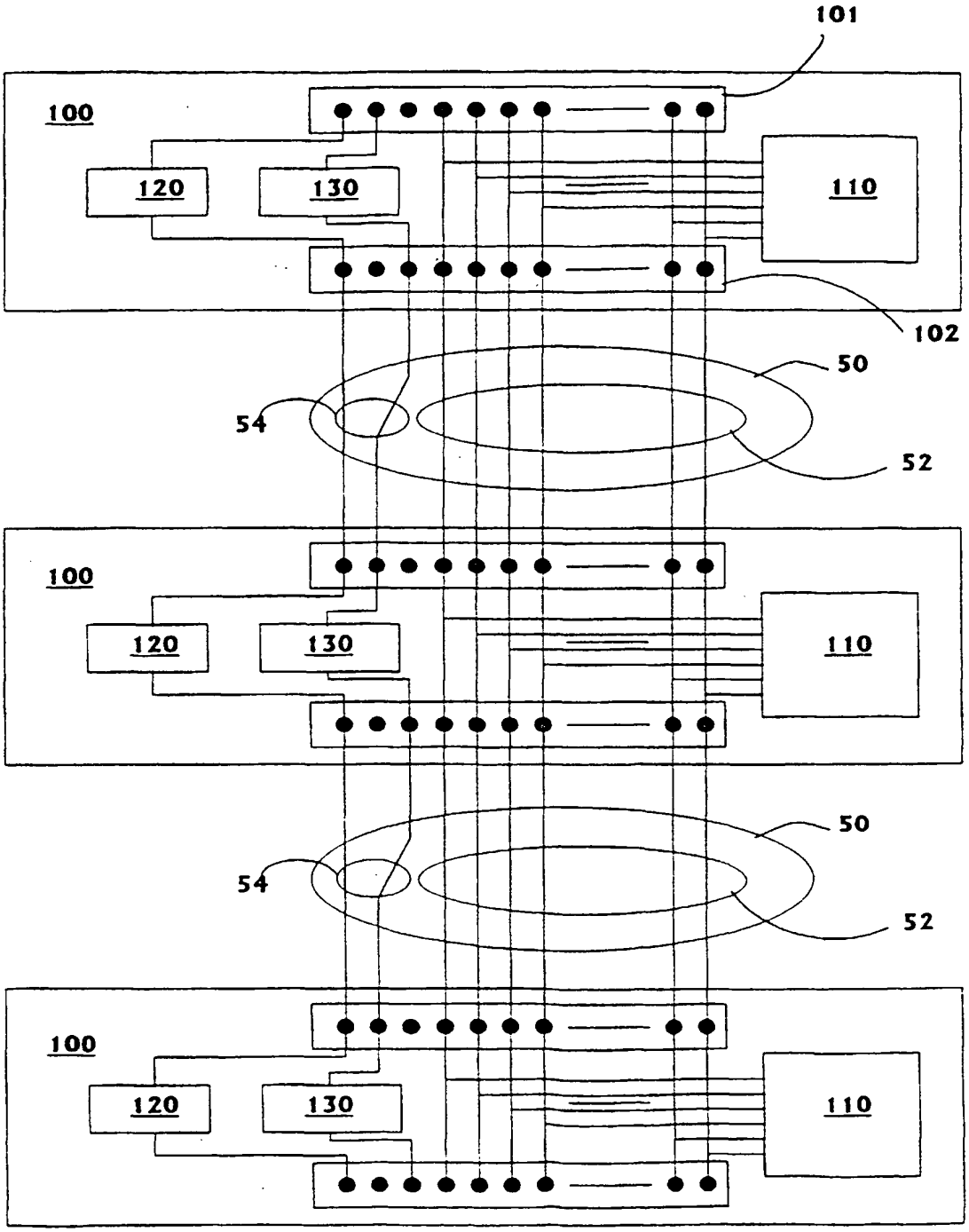
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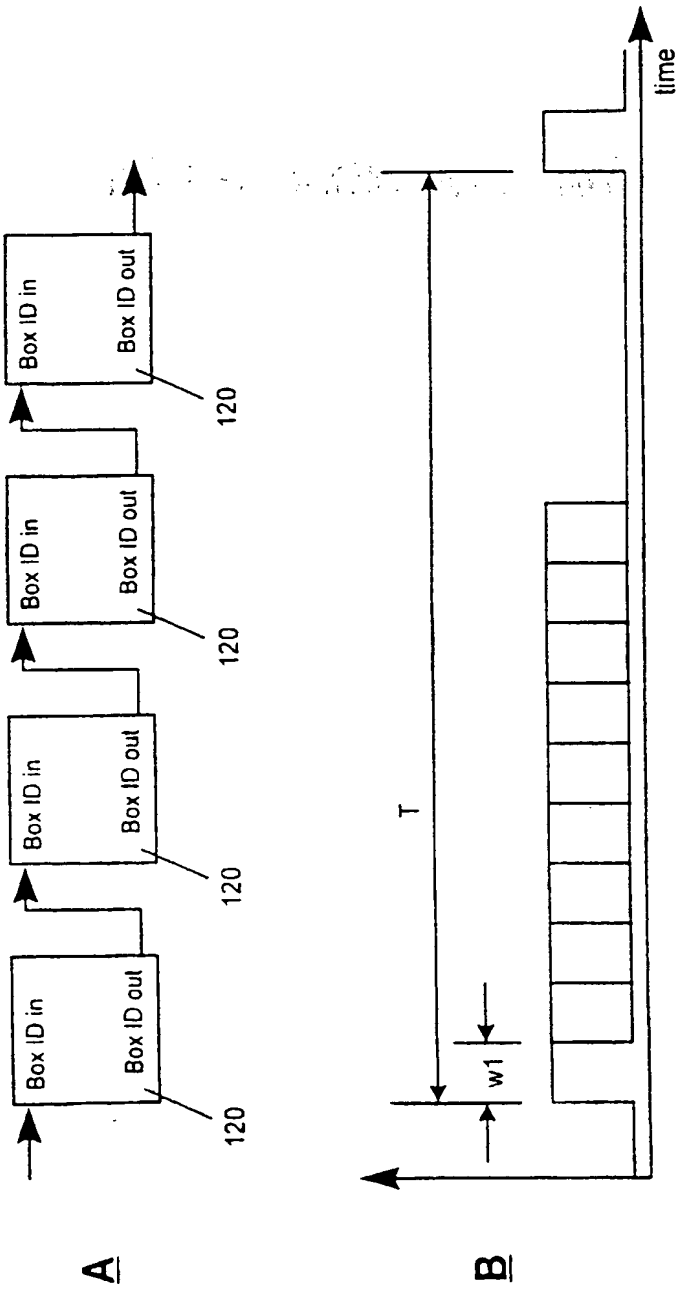
Fig.2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120
A
T
w1
time
B

Fig. 3

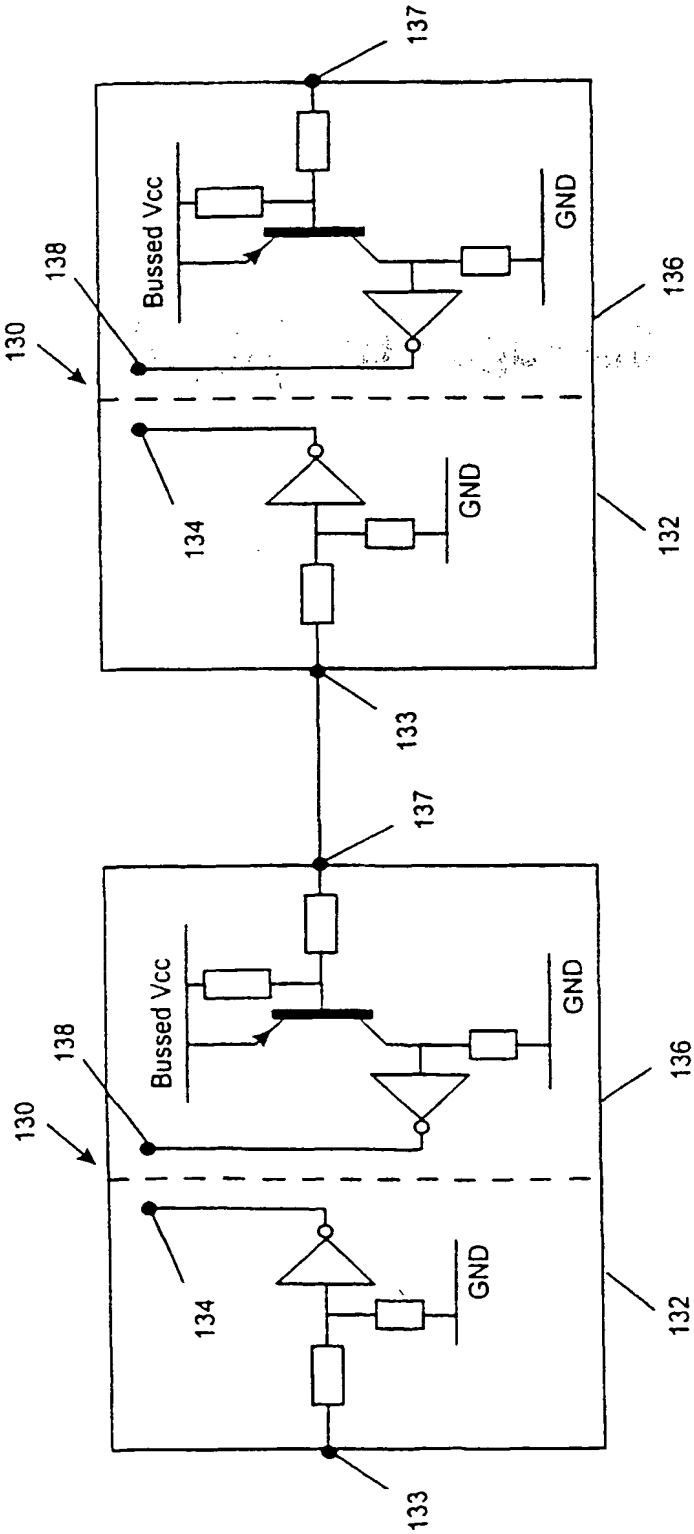
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Fig. 4

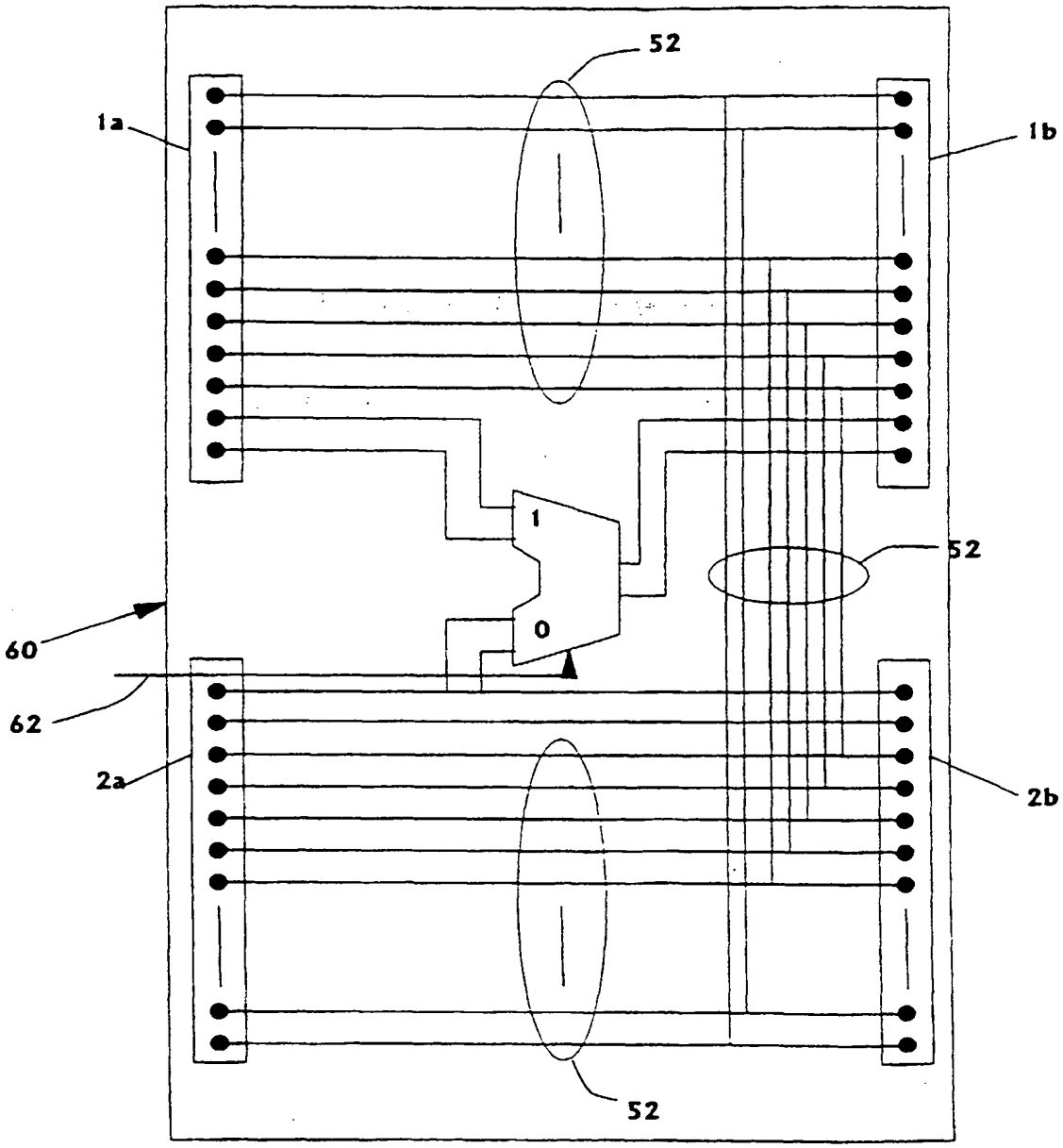

Fig. 5